

How does the tarantula *Lasiodora parahybana* Mello-Leitão, 1917 (Araneae, Theraphosidae) detects its prey?

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How does the tarantula *Lasiodora parahybana* Mello-Leitão, 1917 (Araneae, Theraphosidae) detects its prey? - The various sensory channels involved in prey detection and attack were investigated in the tarantula *Lasiodora parahybana* Mello-Leitão 1917 (Araneae, Theraphosidae). Substrate vibrations appeared to be the most efficient, while vision and the sound produced by the prey only provide additional information.

Key-words: tarantula - prey capture - vibrations.

INTRODUCTION

It is well known that orb-spinning spiders detect their prey by the vibrations of the web produced by trapped insects. The spider is usually pulling the silk threads and detects its prey with specific receptors located mainly at the tip of the legs. For jumping and wandering spiders, it is generally assumed that they get information from several sensory channels: vision, air and substrate vibrations and olfaction.

In most spider families, vision seems not to be the main sense used for prey detection. However, in Salticidae visual releasers are necessary for prey capture. In fact, many studies have demonstrated that they visually detect movements of the prey on a still background (LAND 1971, 1972, DUELLI 1978). Salticidae eyes are the most proficient in the Arachnid group: they have high photoreceptor density and their ability to move the retina enlarges their whole visual field (HOMANN 1928, 1971).

Several studies have demonstrated the role of air and substrate vibrations for releasing capture in many Arachnid species. Thus, BROWNELL (1979) has shown that the sand scorpion (*Paruroctonus mesaensis*) primarily uses substrate vibrations to localize its prey. That stimulus is detected by mechanoreceptor sensilla of the basitarsi of the eight legs of the animal. Air vibrations may also act as a releaser for predation. In *Cupiennus salei* (Ctenidae), prey capture is released by the air vibration produced

by flying insects. The signal is mediated through the slender hair sensilla (trichobothria) moved by the air drafts (BARTH et al. 1995). The efficiency of the releaser was not impaired when the eyes were covered (HERGENRÖDER & BARTH 1983) or if the experiment was performed under red light conditions (BARTH et al. 1993).

Chemoreceptors have also been described in spiders (FOELIX 1985, 1992), but their actual involvement in hunting behavior has not yet been elucidated.

In tarantulas, the respective roles of olfaction, vision, substrate vibrations and air draft, remain unknown. The aim of the present work is to analyze the efficiency of various sensory channels (visual, vibratory and olfactive ones) in releasing prey capture in the tarantula *Lasiodora parahybana*.

MATERIAL AND METHODS

Animals: 10 individuals of both sexes of the species *Lasiodora parahybana* Mello-Leitao 1917 (Araneae, Theraphosidae) were tested. This species is commonly found in the Amazonian forest of eastern Brazil. It usually shelters below logs and free stumps where it digs holes.

Tested animals were from the same breeding stock and had about the same age (between 7th and 9th instars). They were bred individually, in a constant temperature (23°-28°) and humidity (70-80%) room under natural photoperiod.

Spiders usually fed with cockroaches (*Periplaneta americana*) were starving for 10 to 40 days before an experiment in order to be motivated to hunt. They were not tested during at least 15 days before and after a molt.

Experimental device: Each individual spider was kept in a transparent plastic box of about 10.2 l volume (40x17x15 cm). One side of the box (figure 1, A) opened to a cylindrical PCV pipe (6 cm diameter and 12 cm length).

Observations were performed in a cylindrical arena (44 cm diameter) with opaque walls 27 cm high, uncovered to allow video-recording. The pipe of the individual breeding boxes could be connected to a same size hole on the wall of the cylindrical observation arena, at substrate level.

The prey, an adult cockroach, was presented in a plastic cylinder (7 cm diameter x 6 cm high), called "prey-box" further on in the text. The cockroach was leashed from above with a thin thread which allowed the experimentator to keep the insect constantly active during the test. The prey box was usually hanging at the center of the arena, at a variable height according to the required experimental conditions. The prey-box could be modified in order to limit the prey perception for the spider to the sensory channel (s) to be tested.

The video-camera (fixed 70 cm above the arena) and a distant control monitor, enabled the experimentator to follow the spider's behavior, without disturbing it. A dim light at the threshold level for video recording was provided by a 60 W bulb, not visible from within the arena.

Experimental protocols: All experiments were performed, at night, in order to take into account the natural circadian foraging rhythm of this spider species. To

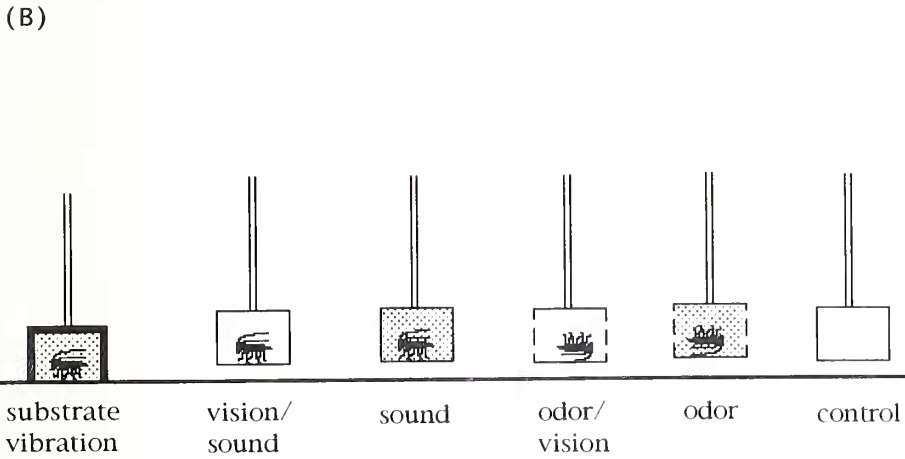
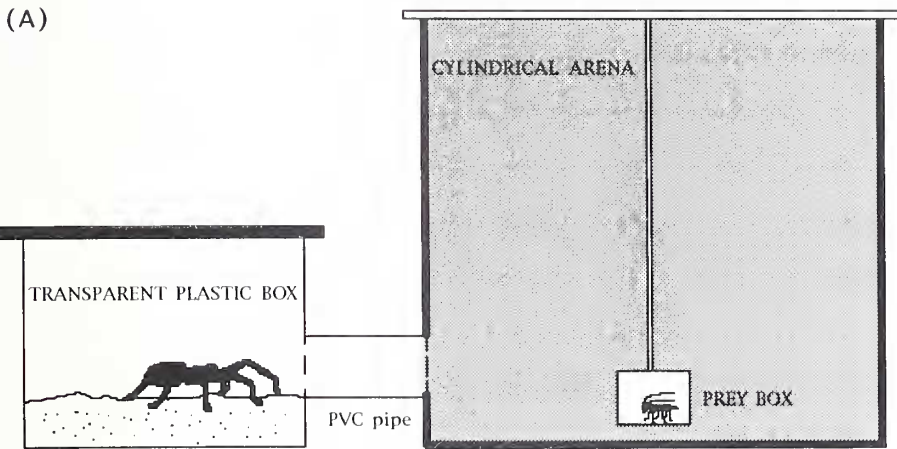


FIG. 1

(A) Schematic drawing of the experimental device. (B) Schematic drawing of the various experimental situations. Bold line: sound isolation, background: opaque box, dotted line: opening permitting the odor's diffusion.

prevent tarantulas from freezing, they were never manipulated before an experiment. The pipe of the breeding box was directly connected to the entrance of the arena 4 days and 4 nights before the experiment to familiarize the animals with the device.

One test began only after attracting the spider into the arena at 7 cm from the prey, with a hand-moved twig, vibrating on the substrate. For each individual and each trial, we have measured the duration between the entry into the arena and the end of the attack, if it occurred. If the spider explored or remained still, we measured the delay between the entry into the arena and the return to the breeding cage. The test was stopped after 30 min if nothing happened; these trials were discarded from the sample.

Control experiments consisted of recording these parameters under standard conditions but without prey.

In a first series of experiments, we tested the efficiency of the substrate vibrations produced by walking prey alone on the substrate of the arena (exp. substrate vibration) (figure 1, B). An opaque standard prey-box was used, with its own bottom removed and acoustically isolated with foam rubber. In a second series of experiments the prey was held in a transparent box, hanging 5 mm above the substrate level. The walking cockroach could be seen and at the same time made some sound (exp. vision-sound). In a third series we tested the efficiency of the sound alone by using an opaque box similar to the transparent one (exp. sound). In a fourth series (exp. odor-vision), we tested the efficiency of prey odor, in a transparent box, on the walls of which small holes were drilled, and which contained a recently killed cockroach (exp. odor-vision). Since, in such an experiment, the prey might be visible, a fifth series of tests was performed, similar to the previous one, but with an opaque prey-box (exp. odor). Vision was not tested alone as it was impossible to prevent any sound from a moving prey. For each of the five experimental series, 10 individuals were tested 4 times, to get a total sample of 40 trials.

Statistics: As our data required non parametric statistics, we used the Mann and Whitney U test (unpaired samples) for the two by two comparisons of time variables and the X^2 test for the frequencies of attacks. The significant probability threshold was chosen at $p < 0.05$.

RESULTS

Frequencies of attacks (fig. 2): Attacks on the prey-box occurred only in the first three experimental series (substrate vibration, vision-sound and sound alone) and of course were never observed in control experiments. Substrate vibrations were significantly the most efficient releaser and vision appeared less important, just providing an additional information when combined with sound. If the spider could not see the prey but only detect its sound, attacks still consistently occurred, but at significantly lower rate. Combined vision and odor or odor alone were unable to release any capture attempt.

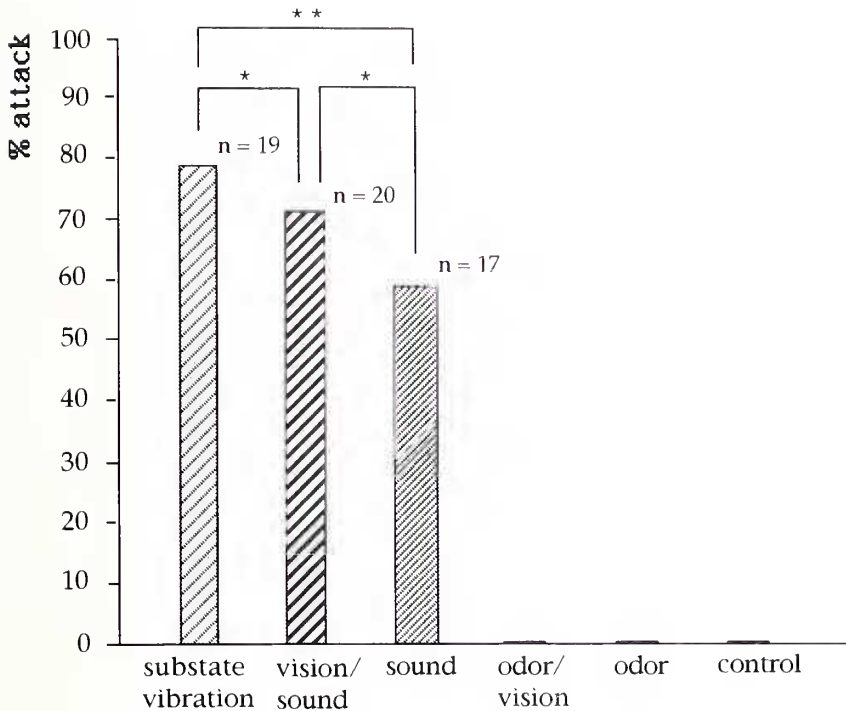


FIG. 2

Percentage of spider attacks on the prey-box in each experimental situation and control tests. X^2 test on the frequencies: * = $p < 0.05$; ** = $p < 0.01$.

Latency (fig. 3): Among the three situations in which we observed an attack, the delay between "enter the arena" and "attack" appeared significantly longer (larger than twice) when the detection was channeled through substrate vibration. The latency was similar for the two other experimental situations, with vision and sound as well as with sound alone.

Exploration duration (fig. 4): In each experimental series, whether attacks occurred or not, for some individuals and some trials, some tarantulas just kept exploring or resting. In each case, we measured the duration of this behavior. There appeared to be a significant difference between two groups of average values: the ones corresponding to the experiments in which attacks did occur and the ones in which attacks did not occur. The values of the former were consistently shorter than the ones of the latter. Among each of these groups there was no significant differences in the average exploration duration.

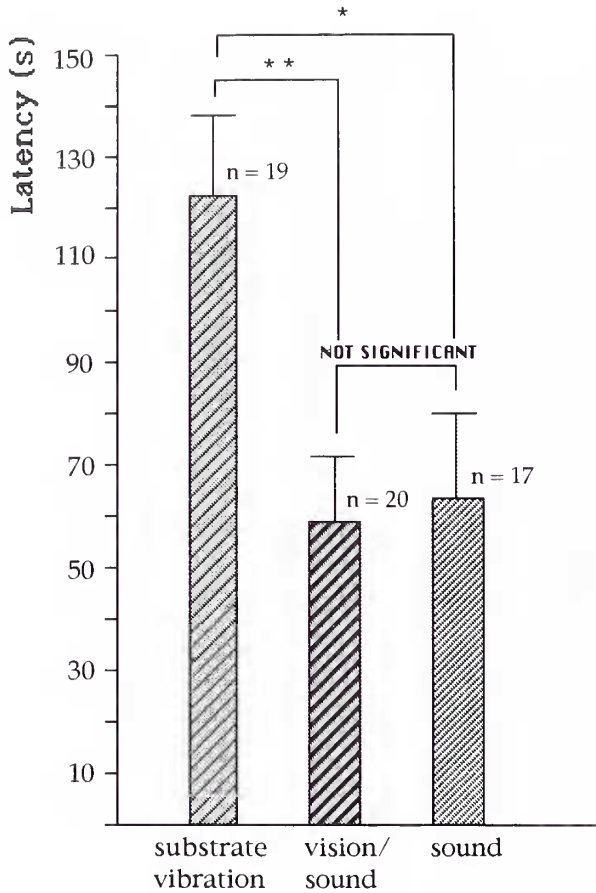


FIG. 3

Average latency of attack (in seconds) in the three situations in which this behavior was observed. Bars on each histogram indicate the standard error of the average. Mann and Whitney U test: * = $p < 0.05$; ** = $p < 0.01$.

Discussion.

When the stimulations provided by the prey were limited to one or two sensory channels, substrate vibrations appeared to be the most efficient stimulus, compared to the combined vision and sound or sound alone. Movement of the prey (which combined vision and sound) seemed also to release some attacks, more than sound alone, which demonstrated at least that vision provided some additional information. On the contrary, odor of a dead prey, visible or not, did not provide enough stimulation to induce catching attempts, in the same way as the control situation when the prey was absent.

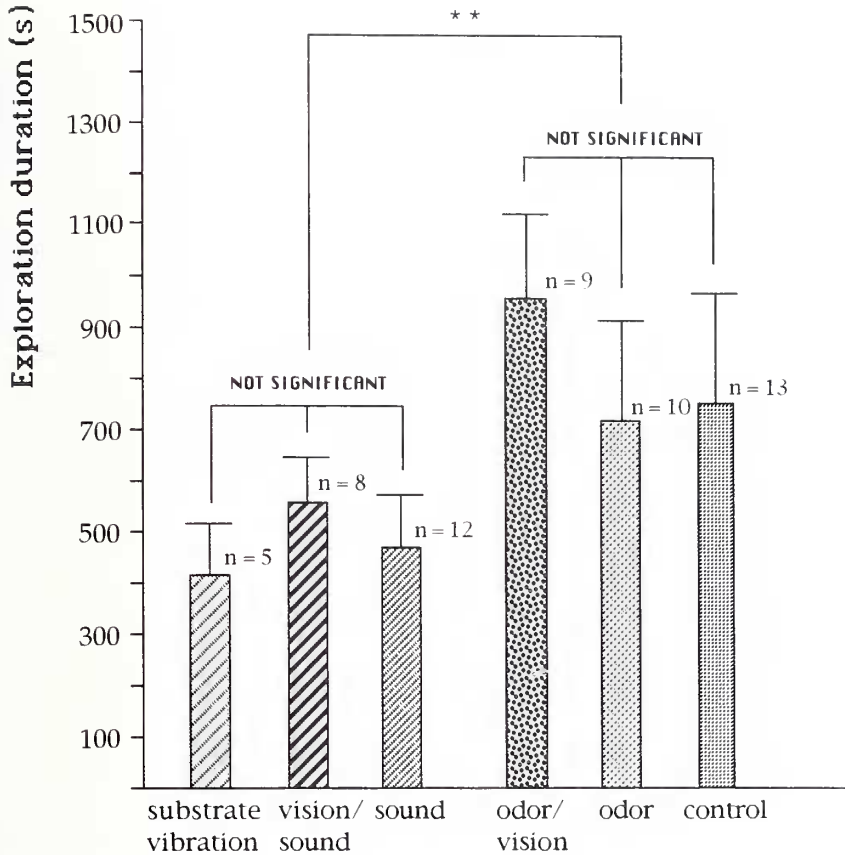


FIG. 4

Average exploration duration (in seconds) for the trials in which no attack occurred for each experimental situation. Bars on each pile indicate the standard error of the average. Mann and Whitney U test: * = $p < 0.05$; ** = $p < 0.01$.

Latency happened to be longer for the most efficient stimulus, i.e. vibrations of the substrate produced by the walking prey (mean = $122 \text{ s} \pm \text{sd} = 15$). It is also noticeable that only in that situation we have sometimes observed usual hunting behavior, with slow walking interrupted by pauses for prey localization. In the two other situations in which attacks also occurred, the spider just jumped on or grasped the prey-box, without any preparation of the capture as reflected by the shorter latency averages (for vision-sound: mean = $58 \text{ s} \pm \text{sd} = 12$; for sound: mean = $63 \text{ s} \pm \text{sd} = 17$).

Data from the average exploration times also require some comments. Each time the prey was detectable (situations substrate vibration, vision sound and sound), the exploration duration was shorter. This could mean that if the animal did not attack the detectable prey, the animal was not hungry enough (not motivated). For these animals, the releasing threshold was higher than for the responding spiders and the stimuli did

not reach that threshold. The stress always induced by any experimental situation might also differentially raise the releasing threshold through a motivation conflict.

In the wild, the situation is certainly quite different, mostly because the stimulations in experimental conditions were probably not optimal. Firstly the prey-box poorly matches the expected signal of a free moving prey. Secondly, in nature, the prey provides a complex stimulus whose characteristics are perceived more or less simultaneously through the various sensory channels. Parallel information processing implying at least an addition of the various information or a non-linear computation which could enhance the whole stimulus, might more easily reach the releasing threshold. Thirdly, the spider attracted out of its breeding box might be puzzled not finding the prey at the precise location where it had localized the vibration signal.

Furthermore, because, in nature, hunting takes place at night, substrate vibrations are probably the most efficient stimulus for capture releasing. The plastic bottom of the arena is possibly not the best for propagation of these vibrations. In the wild, they are transmitted either through the wood of logs or stumps or through the litter of branches and dead leaves. All these materials are probably more efficient for vibration transmission than the one of the experimental device.

Despite these differences between experimental and natural conditions, we can conclude that to detect its prey, the tarantula *Lasiodora parahybana* uses a hierarchy of sensory informations in which substrate vibrations appear to be the most important. Further experiments should investigate the sensory information required to release capture with decoys and free preys under natural conditions.

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